Claims

1. A solid state laser gain medium having first and second ends along a laser optical axis in which at least one end is profiled to provide a level of thermal lensing at a predetermined operating power, in which the predetermined beam quality is centred substantially on a maximum at the predetermined operating pump power.

2. A medium as claimed in claim 1 in which both ends of the medium are profiled.

3. A medium as claimed in any preceding claim in which the gain medium is formed of Nd:YAG.

4. A laser oscillator cavity including a medium as claimed in any preceding claim.

5. A cavity as claimed in claim 4 further comprising flat cavity end reflectors.

6. A cavity as claimed in any of claims 3 to 5 further comprising a Q-switch having first and second acousto-optic cells and respective first and second non-parallel polarisation orientations.

7. A cavity as claimed in any of claims 4 to 6 further including a Q-switch comprising at least one acousto-optic cell having a reflective end forming a cavity end reflector.

8. A cavity as claimed in any of claims 3 to 7 further comprising a frequency converter and a frequency selective reflector between the laser gain medium and the frequency converter.

9. A laser including a medium as claimed in any of claims 1 to 2 or a cavity as claimed in any of claims 3 to 8.

10. A laser as claimed in claim 9 further comprising a side-pumping diode element.

11. A Q-switch for a laser comprising first and second acousto-optic cells in respective first and second non-parallel polarisation orientations.

12. A Q-switch as claimed in claim 11 further comprising a reflective surface arranged to form a laser cavity mirror.

13. A laser including a Q-switch as claimed in claim 11 or claim 12.

14. A Q-switch or a laser comprising at least one acousto-optic cell having a reflective surface arranged to form a laser cavity mirror.

15. An optical gain cavity including a gain medium and arranged to operate at a substantially maximum beam quality for a predetermined operating power.

16. A laser cavity comprising as laser cavity element, a first end reflector, an output end reflector and a gain medium provided there between, the cavity further comprising as a laser cavity element frequency converter between the gain medium and the output end reflector and a frequency selective reflector

between the gain medium and the frequency converter in which the laser cavity elements are aligned on a common physical axis.

17. A laser cavity comprising as laser cavity element, a first end reflector, an output end reflector and a gain medium provided there between, the cavity further comprising as a laser cavity element frequency converter between the gain medium and the output end reflector and a frequency selective reflector between the gain medium and the frequency converterand configured to produce a predetermined beam quality centred on a maximum at a predetermined operating pump power.

18. A laser cavity a claimed in claim 16 or 17 wherein the frequency selective reflector and the output end reflector are arranged to output laser light converted by the frequency converter to be used at a workpiece at the converted frequency.

19. A cavity as claimed in claim any of claims 16 to 18 in which the frequency converter is a second harmonic generator.

20. A cavity as claimed in any of claims 16 to 19 in which the output end reflector reflects the fundamental frequency generated by the gain medium.

21. A cavity as claimed in any of claims 16 to 20 in which the frequency converter has a large acceptance angle.

22. A laser including a laser cavity as claimed in any of claims 16 to 21.

23. A laser ablation device comprising a laser as claimed in claim 9, claim 13 or claim 22.

24. A method of profiling a laser gain medium end comprising to provide a level of thermal lensing at a predetermined pump power such that a predetermined beam quality is achieved at the predetermined pump power.

25. A method of controlling pumping of a Q-switched pulsed laser comprising reducing pump power to a quiescent level between bursts of laser pulses.

26. A laser amplifier having:

a laser cavity; and

an amplifying module external to the laser cavity, said amplifying module sharing a common axis of emission with said laser cavity and comprising a gain medium having first and second ends along said axis of emission, whereby at least one of said first or second ends is profiled so as to directly couple light from said laser cavity into said amplifying module.

27. A laser amplifier as claimed in claim 26 wherein one or both of said first or second ends are profiled to form a lens having a predetermined focal length.

28. A laser amplifier as claimed in claim 26 wherein said laser comprises a gain medium with profiled ends.

29. A laser amplifier as claimed in claims 27 or 28 in which the lens is one of a refractive, diffractive or GRIN lens.

30. A laser amplifier as claimed in claims 27 or 28 wherein said laser gain medium ends are profiled to form a lens having a predetermined focal length.

31. A laser amplifier as claimed in any of claims 27 to 28 wherein said lens of said laser gain medium and said lens of amplifier gain medium have substantially equal focal lengths.

32. A laser amplifier as claimed in any preceding claim whereby said laser gain medium lens and said amplifier gain medium lens are concavely profiled.

33. A laser amplifier as claimed in any preceding claim, wherein said laser and said amplifying medium are pumped simultaneously.

34. A laser amplifier as claimed in claim 33 wherein said laser pump and said amplifying pump have equal power.

35. A laser amplifier as claimed in any preceding claim in which an input surface to the amplifier is tilted.

36. An optical amplifier module comprising a medium having first and second ends, at least one end being profiled to provide a level of lensing at a predetermined operating power, arranged such that, in use, the amplifier can be directly coupled to a laser of predetermined parameters.

37. A module as claimed in claim 33 in which, for an amplifier medium comprising a rod of diameter D_R, length L_R refractive index n_L in air of refractive index n_{air} and thermal focal length f_{th} arranged to receive an input beam from a laser having waist distance d_o from the input rod end, the rod is profiled with a radius of curvature R given approximately by

$$R = \frac{d_o(4f_{th} - L_R)(n_L - n_{air})}{n_L(4f_{th} - L_R - 2d_o)}.$$

38. A method of making a laser amplifier module gain medium comprising profiling at least one end thereof to provide a level of lensing at a predetermined operating power, arranged such that in use, the amplifier can be directly coupled to a laser of predetermined parameters.

39. A method of designing a laser amplifier as claimed in any preceding claim comprising identifying a profile as defined in claims 11 or 12.

40. A laser amplifier as described substantially herein with reference to the accompanying drawings.

41. A method of controlling pumping in a Q-switched, pulsed laser comprising reducing pump power below the laser cavity lasing threshold prior to full-power pumping.

42. A method of converting laser frequency in a laser cavity comprising cooling a frequency converter in the laser cavity to below an optimum frequency conversion temperature while the laser is in a non-lasing state.

43. A laser assembly comprising a medium cavity, laser or switch as claimed in any of claims 1 to 22 and an amplifier or module as claimed in any of claims 26 to 37 coupled therewith.